Fate and Transport Modeling of Urban Radiological Contamination

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The objective of this work is to model the unique precipitation-driven transport characteristics of radiological contaminants dispersed in a ground deposition plume following the detonation of a radiological dispersal device (RDD) in an urban setting; i.e., the U.S. National Planning Scenario #11. Specifically, this case study investigates techniques for mapping overland transport, quantifying residual hotspots for various storm intensities, and estimating volumes of contaminated water produced. The case study model was developed using the EPA Stormwater Management Model (SWMM v5.1) engine implemented within a proprietary software (PCSWMM) that includes a quasi-2D module. To explore the impacts of different precipitation events on the spread of radiological contamination, the case study modified a SWMM model from a combined sewer system from an urban center in the U.S. and used both an MSE Type 3 24-hour 2-year storm and an actual storm with a hourly 2-year return frequency. The multistep modeling process required to develop and implement the case study will be discussed in this presentation as well as a literature review of washoff coefficients for radiological contaminates. The study found that the greatest area of uncertainty in the modeling is associated with the estimates of washoff parameters. Experimental washoff data for radioactive fallout components is available from studies conducted in the 1960s, and there has been considerable data accumulated from areas proximal to recent reactor accidents. The presentation will describe the authors' process for assigning coefficients using historical data and land-use features. Overall, this work illustrates the process of characterizing washoff behavior for a ground deposition plume in an urban setting developed from existing SWMM subcatchments and available urban planning data. The model can provide insights to overland transport pathways and mass flux of contaminants in response to high return frequency rain events. These results provide a functional conceptual model of surface movement of the contaminant and a process that can be applied to other urban and suburban settings.